SOIL CONSERVATION

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AGRICULTURE'S
New Approach to Flood Control

by A. L. Patrick[1]

ON JUNE 22, 1936, Congress passed what is known as the Omnibus Flood Control Act (Public, 738—74th Cong.). This for the first time in history authorized a coordinated land and water program for flood control.

The wording of section 2 states "That, hereafter, Federal investigations and improvements of rivers and other waterways for flood control and allied purposes shall be under the jurisdiction of and shall be prosecuted by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers, and Federal investigations of watersheds and measures for run-off and waterflow retardation and soil erosion prevention on watersheds shall be under the jurisdiction of and shall be prosecuted by the Department of Agriculture under the direction of the Secretary of Agriculture, except as otherwise provided by act of Congress . . ."

IT SHOULD be noted that section 2 actually sets up the purpose of the act while section 6 authorizes the carrying out of specific work on certain watersheds: "The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control at the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and waterflow retardation and soil-erosion prevention on the watersheds of such localities; the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes * * *."

Two hundred twenty-two watersheds were set up under this act and many additions are being made by the present Congress. The wording of section 6 as to location of the places on the watershed where work is to be performed is somewhat confusing. It is easy to understand why, when one realizes that the act was drafted originally with exclusive regard to downstream engineering structures. The words "watersheds of such localities" is interpreted to mean that treatment may be planned for all the land drained by a stream from its origin to the point nearest the mouth.

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The act authorized $10,000,000 to be appropriated and expended in equal amounts by the Departments of War and Agriculture for carrying out any examinations and surveys provided for in the act. Congress adjourned last year without actually appropriating any money for this purpose. The present budget contains an item of $1,000,000 for this work, half of which would be used by the Department of Agriculture. The hearings on the Flood Control Act were just getting under way when this issue went to press.

Three Bureaus Concerned

CONGRESS placed upon the Secretary of Agriculture the responsibility for carrying out the provision of the act regarding runoff and waterflow retardation and soil-erosion prevention in the watersheds. The Secretary has stated that while many of the agencies of the Department will be able to make worth-while contributions, the three primarily concerned are the Bureau of Agricultural Economics, the Forest Service, and the Soil Conservation Service.

M. S. Eisenhower, Director of Information for the Department, was appointed to represent the Secretary in correlating the Department's efforts with those of the War Department and other Federal agencies, and to serve as coordinating officer in the Department. F. A. Silcox, Chief of the Forest Service; H. H. Bennett, Chief of the Soil Conservation Service; and A. G. Black, Chief of the Bureau of Agricultural Economics, serve as an advisory committee with Mr. Eisenhower in formulating policies to be developed, and in establishing the proper procedures within the Department for the efficient conduct of the work.

Committee Set-Up

A "Flood Control Coordinating Committee", consisting of A. C. Ringland (chairman), E. N. Munns, and C. I. Hendrickson, representing the Soil Conservation Service, the Forest Service, and the Bureau of Agricultural Economics respectively, has been set up. This committee has organized machinery and worked out relationships so that when funds are available the preliminary phases of the work can be started without undue delay. Preliminary examination outlines have been prepared. Field committees consisting of representatives of the three bureaus have been named for each of the watersheds mentioned in the bill. Field liaison officers to serve for the field committees in contacting district Army engineers with reference to the holding of public hearings have been named and are functioning. An understanding of working relationships between the Department of Agriculture and the Office of the Chief of Army Engineers has been arranged.

Watershed committees covering work in S. C. S. regions 1, 2, 3, 4, 5, 6, 7, and 9 have met, and methods of procedure for carrying out preliminary examinations have been explained. Cost estimates have been prepared in the field and sent to Washington.

THE preliminary examinations and the surveys are two distinct features of the act. The former is to provide data for conclusions as to whether a watershed survey should be recommended. Surveys are comparatively costly and, as a consequence, are not to be recommended unless there is likelihood of a worth-while program evolving as a result. There are other objectives of the preliminary examinations, such as determining which of the departmental agencies should assume the leadership of various watershed surveys, arriving at some idea as to their cost, and arranging the order in which they should be surveyed.

The Department is responsible to Congress for compiling information and reporting upon every watershed named in the act. In cases where it is evident that a survey will not be recommended detailed preliminary examination reports will not be made. Disapprovals will have to be thoroughly justified, however, since the reasons for rejection will be submitted to Congress by the Secretary.

THE failure of either of the two Departments to recommend a watershed survey will not necessarily mean an adverse report by the other. Both Departments will submit separate reports for each watershed, and their work does not overlap, since each is charged with a specific phase of the control problem.

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Watershed Treatment and Flood Control

By R. H. Davis [1]

IN THE PAST flood control has generally been looked upon as a program for controlling large volumes of water which have become concentrated in major streams by means of levees, floodways, dams, and storage reservoirs. The importance of such installations on major waterways and their tributaries should not be minimized. We must not overlook the fact that floods occurred before settlement and use of the land. Therefore, downstream installations have a very definite function and must be permanently depended upon as an important phase of flood-control work. There is plenty of evidence, however, that man through his activities with ax, plow, herds, and fire has created conditions which make for more frequent and more extensive floods, and insofar as this is true it should be possible for man to establish effective flood-control measures. It is in this margin of difference between natural conditions and man-modified conditions that watershed treatment for flood control may be expected to make its contribution.

In the Omnibus Flood Control Act of 1936, Congress gave recognition to "run-off and waterflow retardation and soil erosion prevention on watersheds" as having a part in flood control. It should be emphasized that, in passing this act, Congress did not condemn downstream control works. The upstream investigations, and the control measures which may subsequently be based on them, are intended simply to supplement and be coordinated with control operations downstream. Conservation workers, engaged as they are in a program to conserve soil and water on the land, are directly interested in, and have a material contribution to make to the mitigation and control of floods. In light of the relation between soil- and water-conservation practices and flood control, it is desirable to evaluate the effectiveness of such work by a careful analysis of the many factors involved in the whole field of land-water relationships.

Just as there are limitations to depending on watershed treatment alone, so are there also limitations to downstream control when used by itself, and these limitations should be recognized by those engaged in flood-control planning. Programs limited to downstream installations do not take into consideration three important phases of the whole problem of accelerated run-off and its attendant evils.

[1] Inspector, Division of Conservation Operations, Soil Conservation Service, Washington, D. C.

First. They make no provision for control of floods which occur periodically on the thousands of small watersheds scattered from one end of the country to the other. These small watersheds vary in size from a few hundred to several thousand acres, and each of them presents a very serious problem to the residents of the valleys. The floods in these individual small valleys may be caused by rains of wide aerial extent and may give rise to critical flood conditions in the larger tributaries downstream. Or, as is often the case, the local flood may be caused by a local rain of high intensity with no serious consequences resulting except in the immediate storm area. Undoubtedly, the sum total of damage occurring in these upper tributaries during the period of a year, or over a period of years, amounts to considerably more than the spectacular catastrophies occurring along the major waterways.

Second. Downstream flood control leaves entirely out of the picture the importance of conserving water on the land where it falls so that it may be put to some useful purpose either by promoting the growth of crops or by replenishing underground water supplies. Scarcely a year passes that does not see in certain localities heavy rains giving rise to serious flood conditions and later in these same communities periods of drought with depletion of soil moisture and ground water supplies. The replenishment of soil moisture and ground water storage are highly important in themselves, aside from the problem of minimizing flood flows.

Third. Flood control limited to downstream work does not take into consideration the conservation of the land from which the flood waters originate. This problem must not be ignored. It is important both from the standpoint of conserving soil resources for sustained agricultural uses and from that of reducing the sediment carried by flood waters. Through shoaling of stream channels and silting of storage reservoirs, flood damage is greatly augmented by the sediment load carried by the stream. The effectiveness of many downstream control structures is thus impaired. Damage to farm lands and other property along the flood plains by deposition of debris is also a most important consideration.

Fundamental Considerations

THERE ARE so many ramifications to the precipitation infiltration run-off relationship that it is impossible to say, quantitatively, just how effective

watershed treatment can be with respect to minimizing floods. Indeed, it probably never will be possible to derive formulas for determining in advance the effectiveness of upstream control. Since there does exist such a heterogeneous variety of factors influencing this relationship, and since the relative importance of these factors varies from watershed to watershed throughout the country, it is important in order to study the problem that it be broken down into its component parts. After this has been done and each factor weighed separately, it is then easier to visualize the influence of all of these factors operating together.

By referring to the illustration of the hydrologic cycle, it can be readily seen that the critical problem is the manipulation of the precipitation as it comes in contact with the earth's surface so as to get a larger proportion of it into the soil rather than to allow it to run off. In other words, we must use the land as a reservoir for water. Few people realize the tremendous possibilities which the land offers in this respect. The soil is not an impervious mass, as is sometimes considered, but rather a loose, porous body, capable of absorbing great quantities of water if given the chance. It is the most effective fresh-water reservoir available.

The infiltration and the water-absorbing capacity of soils are, of course, dependent on a number of factors, the principal ones being intensity of precipitation, slope of the land surface, nature of the underlying strata, characteristics of the soil profile, soil porosity, organic content of the soil, extent of soil cover, and presence of mechanical impedimenta to run-off. Of the factors enumerated, only the last four are subject to modification to any extent.

Porosity of three representative soils [1]

Soil type and location	Depth of sample	Porosity	Calculated maximum possible water storage of the top 3 feet [2]
	Inches	*Percent by volume*	*Inches*
Vernon fine sandy loam, Guthrie, Okla.	0–2½	43.3	14.4
	2½–8	41.5	
	8–22	41.7	
	22–38	39.4	
	38–	40.2	
Muskingum silt loam, Zanesville, Ohio.	0–3½	48.1	16.2
	3½–9	45.1	
	9–17	47.8	
	17–32	45.5	
	32–54	31.3	
	54–	32.7	
Marshall silt loam, Clarinda, Iowa.	0–6½	55.9	20.7
	6½–18½	56.4	
	18½–32½	60.3	
	32½–	58.7	

[1] Middleton, H. E., Slater, C. S., and Byers, H. G. The physical and chemical characteristics of soils from the erosion experiment stations—second report. U. S. Dept. Agr. Tech. Bull. 430, 1934.

[2] The figures under this heading were calculated by Dr. Middleton but not included in the publication.

The porosity of soils varies greatly with the inherent characteristics of each individual soil type. However, it may be markedly improved through increase of organic matter, activity of micro and macro flora and fauna living within the soil, and the decay of plant roots which leave channels to more rapidly conduct water into the soil. An illustration of the amount of pore space possessed by different soils can be obtained by referring to the foregoing table.

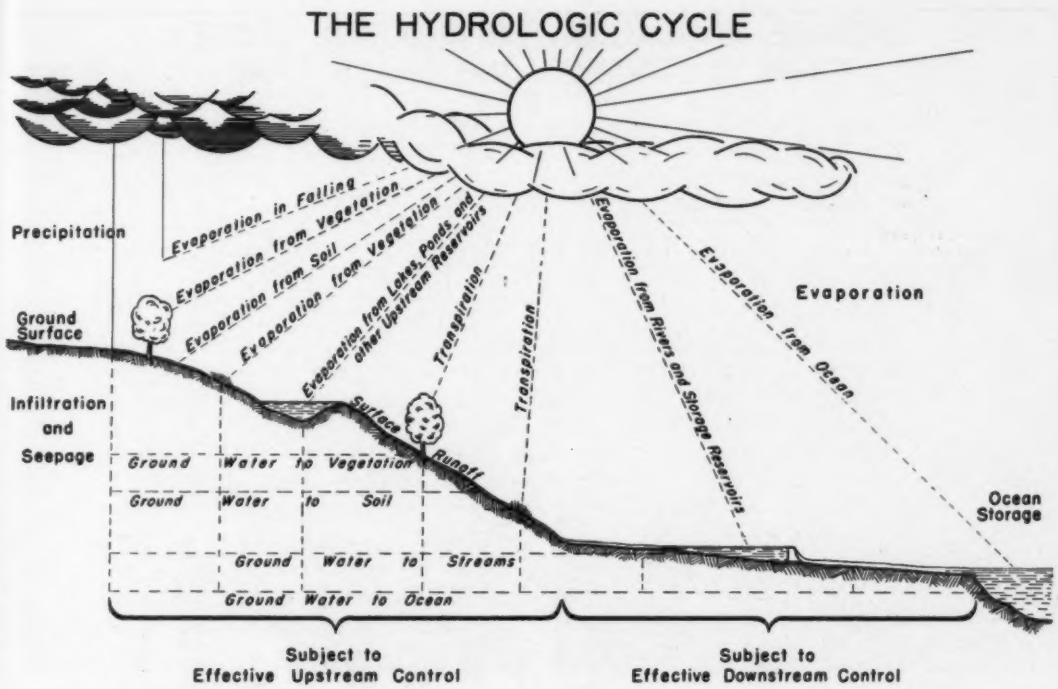
The right-hand column showing the maximum quantity of water which these soils would hold if all the pore spaces were filled with water is, of course, a theoretical calculation. The extent to which the pore space is actually filled when it reaches its total water-holding capacity varies with soil types, and further studies are needed to determine this for given soils. Assumming that only 50 percent of this space is available for water, a relatively easy accomplishment with most soils under proper treatment, it can readily be seen that the upper 3 feet will take care of all except the very heaviest rains. This is to say nothing of the water-holding capacity of the material between the top 3 feet of soil and the ground water.

Many statements have been made to the effect that after the surface soil reaches a so-called state of "saturation" it is then unable to absorb any more water. These statements cannot be substantiated because as the surface reaches such a state and can no longer hold water against the pull of gravity, soil water moves downward into the next lower layer and additional water is absorbed above. Through continuation of this downward movement of seepage water contact eventually is made with the ground water supplies, which when replenished flow out into streams, thus setting up a natural circulation. Although during periods of prolonged rainfall shallow seepage from certain soil types may reach streams in time to contribute to flood crests, generally seepage water is sufficiently delayed so that this does not occur.

Vegetal Cover—Influence on Regimen of Water

THAT vegetal cover and its accumulated litter play a very important part in the utilization and control of water is substantiated by a mass of experimental evidence. This is brought about in the several ways enumerated below:

1. Interception of precipitation.
2. Transpiration.
3. Reduction of evaporation from the soil.



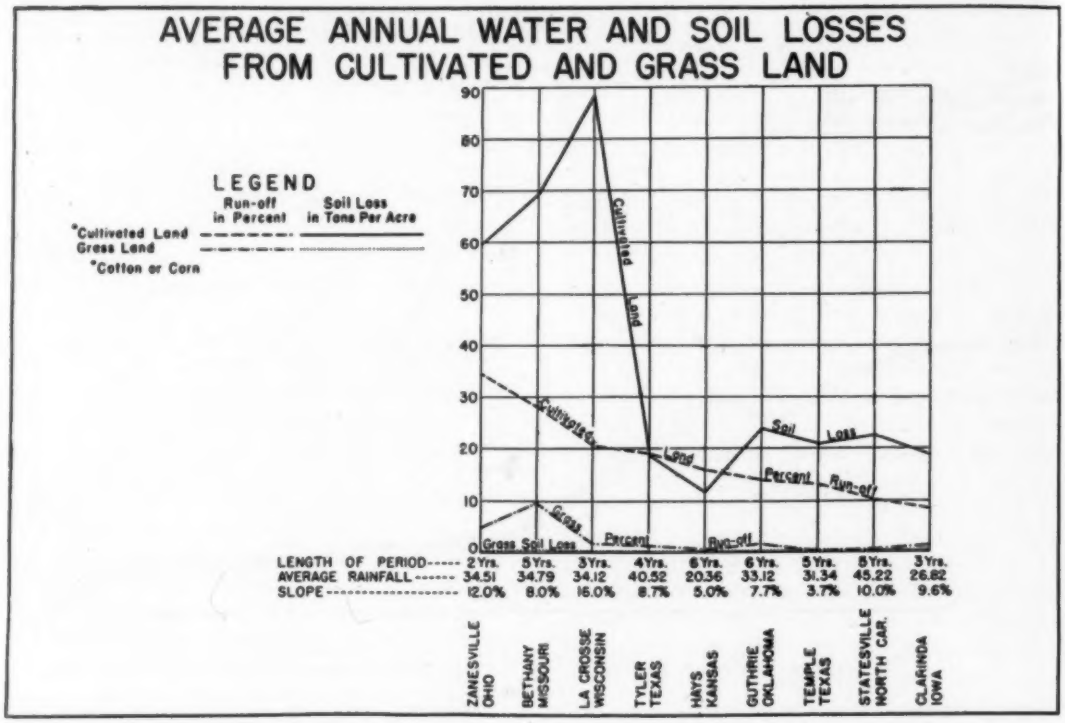
4. Absorption of water by vegetal litter.
5. Mechanical obstruction to run-off by vegetation and litter.
6. Retardation of snow melt.
7. Protection of soil against freezing.
8. Increased infiltration by minimizing clogging of pore space.

The relative importance of each of the foregoing factors varies with type of vegetation, season of year, inherent characteristics of the soil and underlying strata, climatic conditions, etc. It would be most difficult, if not impossible, to isolate the relative influence of each factor for any given set of conditions. It is the combination of several or all of these factors which has given rise to the striking differences noted at all the erosion experiment stations between run-off from grass or forest areas as compared with cultivated land. Invariably, through rain after rain, the effectiveness of good vegetal cover in reducing run-off stands out in a most striking manner at these centers of study as seen in the accompanying table. The quantitative determination of the influence of sod-forming crops on run-off and soil losses, as compared with losses from intertilled crops, is undoubtedly one of the major contributions to modern agricultural science.

Frozen soil conditions are often given as a contributing factor in causing floods. Without doubt this is an important consideration, but we must not overlook the fact that the protective vegetal cover, with the snow which it may hold, has great value in insulating the soil and in minimizing frost penetration. Numerous investigations and observations have proved that soil with a good protective covering of vegetation will resist freezing to a much greater extent than bare ground. Snow cover adds to this resistance. Therefore the attributing of floods to frozen soil conditions over an entire watershed is only assumption, unless thoroughly substantiated by fact.

Other Protective Measures Needed

CERTAINLY no one would advocate the growing of grass or trees on all lands in order to provide adequate watershed protection. It is generally estimated that 350,000,000 acres of cropland would be the very minimum required to meet the food and fiber requirements of our population. However, all but approximately 75,000,000 acres of this required cropland is in need of protection, to varying degrees, against run-off and erosion. The extent of this needed protection depends on slope, degree of erosion, soil characteristics, climatic conditions, and prospective land use.



It is generally recognized that such practices as improved crop rotations, winter cover crops, controlled grazing, contour farming, strip cropping, terracing, contour furrows, make a very definite contribution toward the conservation of water and soil. It is also recognized that structures of various kinds materially contribute to the reduction of water and soil which otherwise would have to be dealt with downstream.

It is unfortunate that quantitative measurements showing the relation of land use and water-conservation practices to floods are not available for large watersheds. Most experimental data thus far have been secured from small areas, and have left out of consideration the extent of concentration which, from the downstream standpoint, is more important than total run-off. There is sufficient evidence, however, to indicate the trend to be expected from a wide application of watershed protection and upstream-control measures.

After consideration of all the basic facts, an inescapable conclusion is that flood control must involve more than the engineering problems incident to controlling large volumes of concentrated water in major streams. It must include the physical and biological problems of watershed protection and land use. Moreover, both upstream and downstream control must encompass the highly complex social and economic considerations incident to the promotion of public welfare. Flood control, in itself, is of no purpose. It must meet the human needs by the protection of life and property and the conservation of natural resources. Flood control benefits directly only those below the areas upon which protective measures are installed. Therefore, the nearer the source of flood water that protective measures are established the greater the number benefited. If we start on the land where the water falls everyone contributes and everyone benefits. It is only with this approach to the solution that flood control can be truly considered as promoting the public welfare.

To summarize, flood-control programs which include watershed protection will:

1. Conserve soil and water on the land for useful purposes.
2. Decrease the frequency of minor floods.
3. Diminish the crests of major floods.
4. Reduce sedimentation in reservoirs.
5. Minimize the silting of stream channels.
6. More nearly fulfill the goal of doing the greatest good for the greatest number.

Type of soil erosion and its fixation, watershed of Brisighella, Faenza, Italy.

WATERSHED CONTROL IN ITALY

By Arthur C. Ringland[1]

THE Flood Control Act approved June 22, 1936 is of historical significance because it recognizes the complementary relations of biology and engineering in flood control. But there is an additional significance of far-reaching implication.

The basic framework for the development of a unified and consistent land policy is provided. Congress has directed that a great number of specifically designated watersheds shall be examined, to determine if measures for the control of run-off and for soil erosion prevention can be economically justified as aids in the amelioration of flood conditions. If measures of this character are to influence flood conditions, there must be the complete coordination of Federal, State, and local agencies within the limits of the watershed. The entire land economy is affected. Thus, a watershed becomes not only a project for flood control but a definitely limited physical compass within which all resources are developed to serve their highest usefulness.

[1] Chairman, Flood Control Coordinating Committee, U. S. Department of Agriculture.

The integration of conservation activities made possible by the Flood Control Act of 1936 has a parallel, interesting if remote, in the Italian national land plan. This plan is based upon the law of Integral Land Reclamation adopted in 1933 and better known as "Bonifica Integrale."

"Bonifica Integrale" has for its objective the stabilization and betterment of rural life in all its aspects. The policy now in effect embraces all measures necessary to promote and stabilize the economic and social usefulness of the land, through the comprehensive development and prudent husbandry of selected areas classified as projects of public interest and utility.

These measures include the following:

1. *Conservation works* in mountain watersheds—prevention of soil erosion through fixation of slopes, and reforestation; correction of streambeds and the control of water flows at their source; improvement and regulation of pasturage; regeneration of deteriorated forests.

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Traveling

ALONG the Ohio River farmers are taking inventory of flood damage and estimating repairs following the greatest flood in the history of the valley. Some are thankful that their houses are not so far off the foundations as to be twisted beyond repair. To be sure, the downstairs walls must be replastered, door frames and window casings repaired, doors and windows replaced, and a new floor laid, but that is much better than having a building wrecked or lying on its side among the willows in the creek. The barn may be intact—or it may be in the neighbor's field, lodged in some grove, or sitting across the road. (One barn in the latter position fortunately had two large doors which could be opened, allowing traffic to proceed "as usual"—through the barn!) The various other outbuildings may be badly damaged or missing. The corn, tobacco, and hay were either ruined or floated away. Most of the livestock is back, safe after a sojourn on the hills, but the chickens which were placed in the barn loft for safekeeping were drowned.

Survey Inception

Losses of this kind can be interpreted rather easily in terms of dollars and cents. On the contrary, effects of the flood upon the fields of Ohio Valley farms are not so easily expressed in figures representing loss or gain. Two general assumptions are usually made in regard to flooded farm land: First, large quantities of soil—presumably from the uplands—will be left on the flooded lands when the waters recede; and second, these deposits are rich in plant food and are a benefit to the land. But was there a valuable deposit left on the valley lands by the recent Ohio flood? Concrete data and not general assumptions are necessary to answer this question.

Late in January, Dr. H. H. Bennett requested the Section of Conservation Surveys and the Section of

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The pictures on these two pages serve as indices of the terrific damage inflicted on buildings and fields by the recent floods—silting and sand depositions, gouging of holes and channels, the removal of good soil from around roots, the accumulation of debris and the wreckage of homes.

Soils

by Mark H. Brown

AN EROSION SURVEYOR VIEWS THE FLOOD ZONE

Sedimentation Studies to investigate the condition of the farm lands and urban areas in the flooded zone from Pittsburgh, Pa., to Cairo, Ill. The Section of Conservation Surveys was designated to study farming areas, and a party from the eastern field survey office began field work at Pittsburgh on February 19. Some delays resulted from frozen or snow-covered ground, and muddy roads checked our progress in certain areas. At times it was necessary to use rowboats and motorboats to reach out-of-the-way places. However, at the present writing (March 28) but a few days of field work remain, and practically all of the observations have been made on areas not yet disturbed by farming operations.

Data Mapped

The general plan has been to survey cross sections of the valley approximately one-half mile wide at 5-mile intervals. Since no previous surveys were available for a guide, the mapping technique was developed by the survey party after a study of the field conditions. Three factors were recorded on the maps:

1. Estimated amount of deposit or removal.
2. Nature of deposits or estimated removals (fine sandy loam, silt, silty clay, etc.).
3. Land use or cover—clean-cultivated, pasture, weedy fields, timber, etc. (These were grouped according to the role each played in deposition or removal.)

Excellent base maps for this work were obtained from the United States Army Engineers. From Pittsburgh to Louisville all data were recorded on Ohio River Charts at a scale of 600 feet to 1 inch. From Louisville to Cairo all areas near the river requiring the mapping of considerable detail were also mapped on these charts, while the wide expanses of valley were mapped on Ohio River Flood Plain Charts on a scale of 2,000 feet to 1 inch. With these maps it was possible to record much detailed information, and to do the work quickly and accurately. In addition to the mapping, samples of deposits were taken for moisture and other analyses, and a careful set of notes was kept of all information not clearly set forth on

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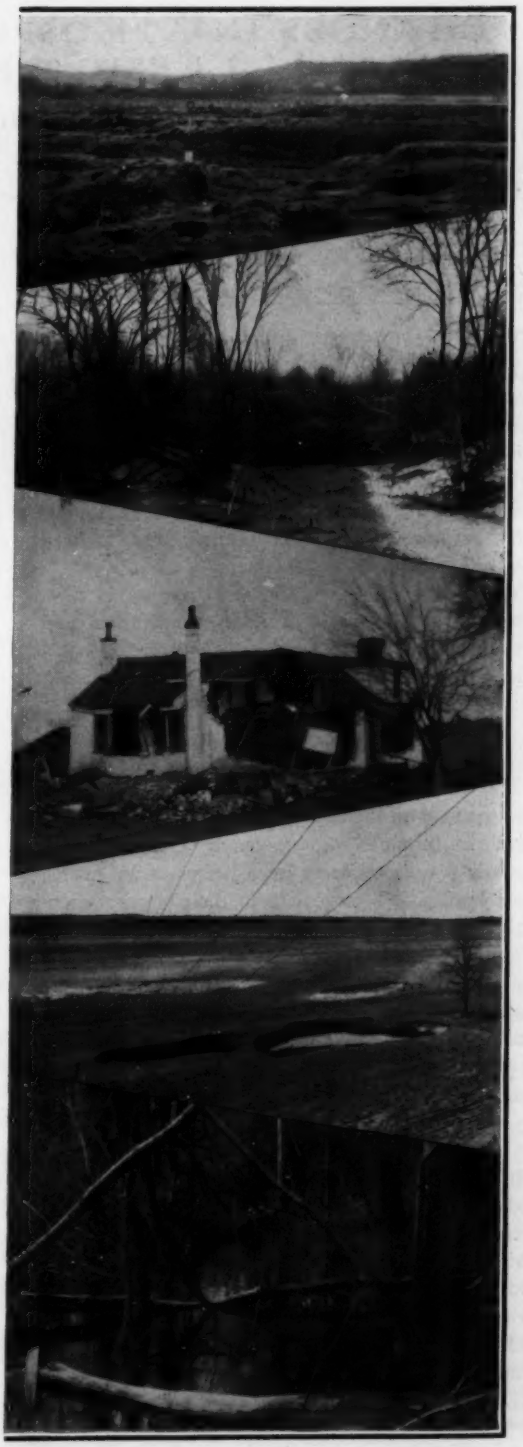
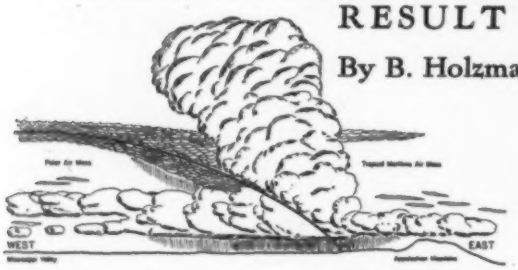


CHANGES IN ATMOSPHERIC CIRCULATION RESULT IN FLOODS

By B. Holzman and K. Clarke-Hafstad [1]



THE FREQUENT occurrence of floods and droughts during the past few years has made everyone acutely conscious of the climate. We know that the climatic elements such as temperature and rainfall of any particular region undergo periodic daily and seasonal variations; but the unexpected aperiodic variations are brought forcefully to our attention because they often result in such national disasters as droughts and floods.

We usually think of a climatic province as characterized by a certain average temperature and precipitation, but these values are derived from a wide range of variations and the average seldom if ever occurs.

The Climatic Province

The variations result fundamentally from significant changes in the general circulation of the atmosphere, which in turn are accompanied by changes in the prevailing trajectories of large bodies of air having great horizontal homogeneity in their physical properties. The boundaries between air masses are called "fronts." The greatest amount of precipitation for the United States occurs at these boundaries, where warm moist air bodies slide up over cold dry air bodies. Thus a climatic province is fundamentally characterized by a certain frequency of invasion of various types of air masses.

Climatic Shifts

In the Northern Hemisphere the distribution of land and water is such that two centers of high atmospheric pressure known as quasistationary anticyclones are maintained in the middle latitudes over the Pacific and Atlantic Oceans. Frequently these circulation centers change in intensity and geographical position, and are accompanied by a shift in meteorological conditions throughout the country which occasions profound climatic changes. The shift in the circulation system is also associated with a change in the prevailing trajectories of air masses. The physical properties of these large atmospheric currents are then modified in response to their altered paths. As a result a period normally expected to be warm and dry may actually be cold and wet.

The excessive precipitation of January 1937 in the Ohio Valley can be explained by a change in the meteorological conditions usually influencing that region. In 1914, Humphreys [2] pointed out that a shift to the west or a westward extension of the Azores quasistationary anticyclone was accompanied by abnormally high temperatures in the eastern United States and by low temperatures in the central and western parts of the country. The temperature departures were in complete coincidence with the meteorological conditions.

Causes of Excessive Precipitation

The atmospheric circulation around the Azores anticyclone is such that when the center of the "high" maintains its normal January position as shown on fig. 1, large quantities of Tropical Marine (Tm) air whose warm, moist properties are acquired over the ocean waters of the Sargasso and Caribbean Seas, are transported northward over the western North Atlantic Ocean. Cold, dry Polar Continental (Pc) air masses, whose origin is over the Arctic tundra of northern Canada, then invade the entire eastern United States and the most vigorous interaction of the two air bodies occurs over the Atlantic Ocean.

With an intensification and westward extension of the Azores anticyclones, as occurred in January 1937, there is a decline in the velocity of the Polar Continental air masses as they proceed south-eastward and the principal zone of contact with the Tropical air occurs over eastern United States instead of at sea. This was indirectly the cause of the abnormally high temperatures of last January in the eastern portion of the United States. The cold, dense air mass served as an invisible barrier to the Tropical Marine air, which ascended aloft along the boundary surface, furnishing

[1] Assistant soil conservationists (Climatic Research), Section of Climatic and Physiographic Research, Soil Conservation Service.

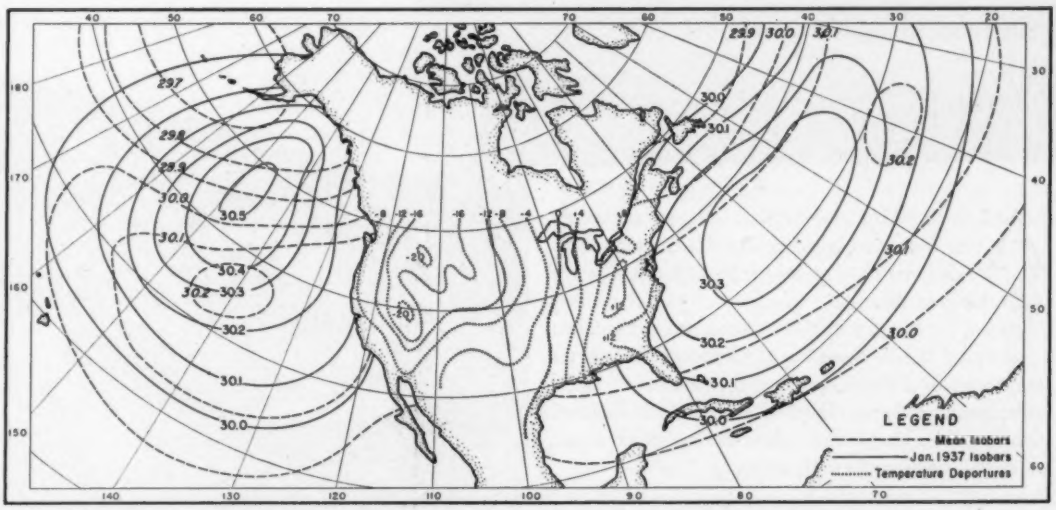
[2] Humphreys, W. J.: Why Some Winters Are Warm and Others Cold in the Eastern United States, Monthly Weather Review, vol. 42, pp. 672-675, December 1914. (35 charts.)

an endless supply of moisture for precipitation as long as these conditions were maintained.

As yet we do not know what relationship exists between the outbreaks of Polar air and the intensity and position of the quasi-stationary anticyclones. The explanation may be discovered by further investigation of the source areas or it may require research concerning disturbances of the stratosphere or variations in solar energy.

Mammoth Cloud Systems

Figure 2 is a diagrammatic cross-section of the atmosphere from west to east across the Appalachians during one of the typical rainstorms that occurred in the Ohio Basin last January. Even though the vertical scale is greatly exaggerated on the diagram, the wedge of cold Polar air is a far more formidable barrier than the the Appalachian Mountains which extend to only



Widespread Rainfall of January

In January 1937 the velocity of the Polar air masses invariably diminished to such an extent that the line of contact with the Tropical air bodies became nearly stationary after reaching and paralleling the western face of the Appalachian chain. This entire frontal zone then, in meteorological terminology, was characterized by "fronto-genesis", meaning that the boundary between Polar and Tropical air currents became more sharply defined. Oscillatory movements were consequently produced along the boundary, and these, as has been shown in detail by the Soil Conservation Service climatic project in Oklahoma,[3] are a controlling influence in the type and intensity of precipitation. Because of the westward extension of the Azores anticyclone in January, the fronto-genetic field paralleled the western Appalachian area and permitted a tremenduos volume of warm, moist Tropical air to ascend aloft over the cold Polar barrier, resulting in widespread rainfall.

one-third or one-fourth of the height of the air mass. Condensation begins with the formation of alto-stratus clouds from which a steady light precipitation soon falls. As the lower levels of the atmosphere become saturated by the precipitation, lower cloud decks such as stratocumulus and stratus develop and may eventually coalesce into a single cloud system as much as sixteen or seventeen thousand feet in thickness. The resulting rainfall is known as the "warm-front type" and produces an extensive steady uniform pattern that may conceivably be maintained for several days. However, this rainfall pattern may become considerably complicated if the transport aloft of the Tropical Maritime air is sufficiently active. Huge convective currents may be created after a certain critical ascension is attained, and manifest themselves in the form of cumulo-nimbus clouds that may extend to an elevation of thirty to forty thousand feet. Convection generally results in precipitation that is extremely variable in intensity, amount, and distribution, but it is most likely to produce downpours which may cause serious soil erosion. The soil erosion

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[3] Corwin, Leonard B., Sampling the Weather at the Oklahoma Climatic Research Center, p. 237, April 1937, Soil Conservation.

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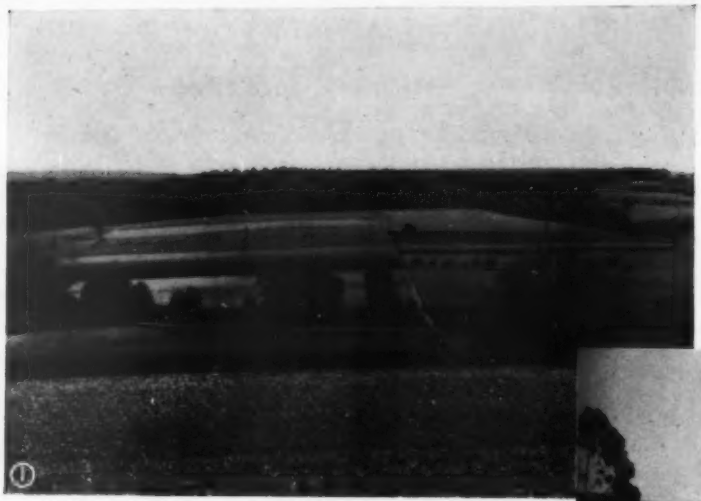

ALL SOUND PLANNING is based on a definite objective, a comprehensive inventory, an adequate history, and a broad knowledge of applicable controls.

Soil and water conservation is not an end in itself, but a means by which a nation can preserve natural resources, control floods, prevent impairment of reservoirs, maintain the navigability of rivers and harbors, protect public health and public lands—all of which are in the interest of public welfare.

Values—Individual and National

When public funds are being expended, benefit to the individual farmer for whose land plans are being made must be considered as secondary to the public benefits. This should not be construed to mean that the plans for the individual farm should not benefit the operator by aiding in maintenance of his soil and conservation of the rainfall for crop production. In this respect, a benefit accrues to the farmer through the safeguarding of his capital stock, the land, and by making possible the utilization of the land and the conserved water for his personal profit, over a long period of years. In this regard, the long-time benefits to the individual are common to those of the Nation as a whole. The immediate benefits to the individual should be sufficient to convince him of the value to himself and his children of carrying out a program that will attain the desired end.

The Watershed Approach

Because of the broad objectives of soil conservation, the watershed approach has been used by the Service in its demonstrational program. Little can be accomplished toward flood control, prevention of impairment of reservoirs, or maintenance of the navigability of rivers and harbors, if only isolated farms adopt conservation measures. Food waters and silt loads do not stop at farm boundaries, nor at county lines, hence the need for community action on a watershed basis as an

ING FOR SOIL AND WATER ··
NSERVATION

by E. J. Utz

Head, Section of Erosion Control Practices, Soil Conservation Service, Wash., D.C.

additional objective in a program designed to conserve soil and water.

Bearing in mind these broad objectives which can be attained through a soil- and water-conservation program, the planner must turn his attention to an inventory of conditions as they now exist. The fact that Cecil sandy loam is excellent cotton soil does not guarantee that the soil in its present condition is capable of producing an excellent crop of cotton. With the topsoil removed by erosion, this soil drops to the level of inferior soil types for crop production purposes. Even though a portion of the topsoil remains, the topography may be such that continuous use of the land for rowcrop production will eventually cause washing away of the remainder.

In a comprehensive inventory the erodibility of the soil, as well as its normal productive capacity, is important, It follows, therefore, that the extent of erosion, the degree of slope, and the soil type are three significant factors for a physical inventory. A fourth factor, land use, or present vegetative cover, is also important, not only in explaining why present conditions of erosion exist, but also as a starting point in outlining future programs of control. A physical inventory is not the only prerequisite for proper planning on farm and range lands. The ideal erosion-control and water-conservation plan might involve the retirement of large acreages of land from cultivation to forest and permanent grass cover. Such wholesale conversion would leave the farmer with too little cropland from which to produce agricultural products, thus seriously curtailing his income.

The same curtailment of cropland would throw production out of balance with the food and fiber requirements of the Nation, with resulting scarcity and high prices. Consequently, the farm organization must be disturbed as little as possible. In order to determine the requirements for a stable farm organization, an economic inventory must also be made. Both the economic and physical inventory, then, are necessary for planning work.

Proper land use.

Severe erosion in orchard.

Basin listing on contour.

Contour strip cropping and terracing.

Improper land use.

The third basic requirement for farm planning is an adequate knowledge of the history of the area to be planned. What crops have been grown on the land, and under what cultural practices has the land arrived at its present condition?

On one farm, where Miami silt loam is the predominating soil type, serious erosion may have taken place because of the continuous cropping to clean-tilled crops, with the rows running up and down the hill. The organic matter content of the soil is very low, with the resultant poor physical condition. On such a soil, the percentage of run-off is large, and the absorption very low.

On an adjoining farm, under similar soil and slope conditions, where an adequate rotation of row crops, grain, and grasses and legumes has been continuously carried out, with the cultivation on the contour, and under a system of strip cropping, practically no soil has been lost. The soil is in good physical condition and absorbs rainwater readily, resulting in a small percentage of run-off. A comparison of the history of these two farms not only explains why the one is seriously eroded, but points out the remedy to be applied in planning a conservation program for the other farm.

period of years it may be brought back to a satisfactory productive state.

Farmers' Discoveries Applied

Most of the practices being advocated in soil-conservation work today are those that have been discovered and applied here and yonder by the best farmers of the Nation. Delving into the history of the various farm units provides the picture as resulting from conservation of our land resources on the one hand, and their exploitation on the other. Research studies have perfected many of these practices found here and there, and pointed the way to their widespread application in other areas.

Often, the application of individual control measures is considered all that is necessary in conservation planning. Such a viewpoint is similar to that of the doctor who prescribes quinine or castor oil for all his patients, on the theory that one of these two remedies will be beneficial in a majority of the cases, or at least seldom harmful. The successful planner, like the successful doctor, must first make a diagnosis of the patient's condition, determine the history of the case, and then prescribe the remedies which will effect a cure. The patient who delays too long in seeing the doctor may not respond to the treatment, and his con-

Wide-row contour planting of milo in preparation for fall wheat planting, in Dalhart Co., Tex. Effective in holding soil until next crop is planted.

The old adage "An ounce of prevention is worth a pound of cure" is certainly applicable in conservation work. The farm that has been operated without regard for conservation will need the "pound of cure" in the form of additional practices, such as heavy fertilization, utilization of green manure crops, longer rotations, and the like, in order that throughout a

tribution to society comes to an end. Likewise, some of our land has been allowed to deteriorate to such an extent that its productive capacity is lost, and it must now be utilized for purposes which are not so intensive as crop or livestock production.

As has been mentioned above, both the broad or long-time and the immediate or restricted objectives must

Orchard with trees planted on contour. Erosion control effected by use of terraces, vegetated strips, and contour operations.

be kept in mind in applying erosion-control measures. In areas where floods and silting are not important considerations, major attention can be given to the conservation of soil and water for crop and livestock production. Here the restricted objectives prevail, and the interests of the operator and the nation closely parallel. Where the control of floods and the reduction of silt is of paramount importance, the interests of the operator, at least the immediate interests, must be secondary to those of the public. In most instances controls in the latter case will need to be more drastic from the point of view of the operator.

A major consideration in planning is the determination of proper land use. Certain soil types, especially under certain slope conditions, are not suitable for the production of cultivated crops unless the operator is content with heavy soil losses. In the same situation, the utilization of this land for pasture or hay crops, where they are kept under adequate vegetative cover, may not only conserve the soil but at the same time return greater profits to the operator. The same soil type, under steeper slope condition, or a different soil type under the same slope condition, may have its most effective use only under forest cover. The farm planner must have a sufficient knowledge of the behavior of different soils under different conditions, in order to plan adequately for proper land use.

Land use, however, is affected by the extent to which it is practical to apply measures of control which will aid in soil and water conservation. Increasing the humus content of soils, using a cropping system which will provide dense vegetative cover on the land during seasons of heaviest rainfall or strongest winds, contour cultivation, terracing, strip cropping, and contour furrowing—these are among the control measures on cropland that may be applied to modify land use. Without the use of one or more of these control measures, certain lands could not safely be cultivated. Furthermore, the application of these controls enables the farmer to use a much larger percentage of his farm land for crop production. Thus the determination of land use and the application of control measures are dependent one upon the other.

The Means to the End

The effectiveness of the various control measures depends upon their relative value in providing protection against the action of water and wind, and in retaining as much rainwater as possible where it falls. Seldom does any individual control measure meet the needs of the situation. Used alone, contour tillage, or terracing, is not sufficiently effective, but a combination of these with adapted rotations, especially when used as contour strip cropping, does provide the necessary protection.

Much has been written and said as to the relative effectiveness of contour cultivation, terracing, strip cropping, rotations, cover crops, and the like, in the conservation of soil and water. Suffice it to say that the ability of the planner to select the proper combination of these control measures to fit the infinite variety of conditions found on farm and ranch, determines success in conserving soil and water, and in attaining the broad objectives of the national program.

FARM MANAGEMENT INFORMATION NEEDED IN FARM PLANNING

By E. H. Reed[1]

THE fundamental basis of the soil-conservation program is wise land use coupled with proper soil-conservation practices, such as contour cultivation, strip cropping, or terracing. Three groups of factors should be considered in farm planning, namely; physical factors, economic factors, and human factors.

Physical Factors

It is generally agreed that physical factors, such as soil type, slope, and degree of erosion, are fundamental and must be taken into account in developing a plan of work for an area or for an individual farm. While these factors can be determined roughly through inspection by the conservationist even though he is not a trained soil scientist, they are considered so important that a detailed conservation survey is deemed desirable to obtain more definite information for use in farm planning.

Economic Factors

The economic factors likewise are fundamental. The farmer should be interested in conserving soil for the use of future generations, and at the same time, he is in the farming business primarily to obtain an income rather than to conserve soil. If the soil-conservation program unnecessarily reduces this income or necessitates considerable additional labor or inconvenience, he will not follow it. Furthermore, if the farm plan is economically unsound and the farmer ceases to follow it, he may feel that the erosion-control practices such as strip cropping or terracing are to blame, whereas the real cause may be a faulty economic set-up. Thus, if the demonstrations are to be effective and the practices spread to other farms, the program must be economically sound and feasible.

In developing a program for an area or for an individual farm, the conservationist sets up both the land use and the methods which are to be followed by cooperators for the next 5 years and which he recommends to be followed generally for a more extended period of time by other farmers similarly situated. This places upon the soil conservationist a great responsibility. He must be sure that his recommendations are economically sound and feasible, both from a short-time and from a long-time standpoint. It is probable that in many instances in the past, insufficient attention and study have been devoted to these economic aspects.

How may the conservationist determine whether the proposed program is economically sound? The physical factors can be seen, while the economic factors must be discovered through study. It is therefore essential that certain farm-management data be obtained and carefully analyzed previous to planning the program for an area or for the individual farm.

The economic feasibility of shifts which are desirable from the standpoint of soil conservation should be considered. Probably the easiest method of reducing erosion on sloping land is to remove this land from clean-cultivated crops and place it in close-growing crops such as hay or pasture or to shift from row crops, as corn or cotton, to close-growing crops such as small grains. To what extent will the farmer be able to utilize these products, either for feed or for sale as cash crops? What effect will such shifts have on his farm income?

In many instances it may be desirable to make less marked changes in type of farming, and more radical changes in methods of farming, such as the adoption of contour cultivation, strip cropping, or terracing. In most regions, especially in the older areas in the eastern half of the United States, the present type of farming is the result of long years of experience, determined largely by the method of trial and error. In such areas, there are ordinarily some fundamental economic reasons for the present type of farming, and in these areas radical changes might lead to serious consequences. On the other hand, in some of the newer sections of the country, marked changes in type of farming have taken place in recent years, and it may be that still others are desirable. The conservationist should not be averse to changes in type of farming, but before such adjustments are recommended, he should be sure that they are economically sound, and that the farmer can adjust his operations accordingly.

The human factors must also be considered—the farmer's training, experience, and ability. He may have acquired certain knowledge and skill in handling particular enterprises, while he may know but little about others. Again, his likes, dislikes, and aptitudes

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must be considered. The cash-crop farmer may not like a year-round job such as livestock production, or the hog farmer may be averse to milking cows. A program which involves marked changes may cause him to refuse to follow soil-conservation practices.

The consideration of these important, and at the same time somewhat intangible, economic, and human factors should not dampen the soil-conservationist's ardor for desirable changes in either land use or methods. It is agreed that in the interests of both private and public welfare, something must be done to prevent the present rate of erosion. However, recommendations for physical changes should be made only after careful study of the economic and human factors, and after it has been determined that the program is sound in all aspects. If this is done, we may feel confident of a spread in recommended practices.

Needs for Farm-Management Information

In the consideration of economic factors, certain farm-management data are necessary. The use to which the information is to be put will, to a considerable extent, determine the kind of data which should be obtained. This information is needed for three specific purposes in farm planning; first, to help determine the plan of work for the area; second, to fit this general plan to the needs of the individual farm; and, third, to study the effects of the application of the plan to the individual farm, and to determine what, if any, changes are needed in the plan.

Plan of Work for the Area

Farm-management, as well as conservation surveys, should be made in a newly designated demonstration area, to serve as basic information for the plan of work. The farm-management data are essential in determining the economic soundness and feasibility of the changes in land use or methods which are shown by the conservation surveys to be worth while. Such data may be obtained by the making of farm-management surveys on a well-selected sample, consisting of from 15 to 25 percent of the farms in the area. The farms surveyed should be representative of the type of farming, size of farm, soil type, topography, and quality of farming.

This survey should be a complete income survey showing land use, the acreage and yield of various crops, the kinds and amounts of livestock, the amount and value of crop and livestock sales, the amount of products furnished by the farm for the family living, and the various items of expense. These data should be completely summarized and analyzed so as to show the incomes, the factors affecting incomes, and the strong and weak places in the present methods of farming. In analyzing this information, it may be well to compare the organization and methods used on farms obtaining high returns with those of farms obtaining low returns.

In order to determine the correlation of the physical and economic factors, the data obtained from the farm-management survey should be studied in connection with those obtained from the conservation survey. Changes suggested by the need for soil conservation should be carefully studied so that they may be made to fit in with the farm-management program. Likewise, the changes desirable from the farm-management standpoint should be studied as to their soil-conservation implications. Data which show only the static picture of the present farm organization are of comparatively little value. They should be so analyzed as to show what changes are required. If the plan of work is developed with the aid of this kind of information, it should result in a program which is sound and feasible from the standpoints of both soil conservation and farm management.

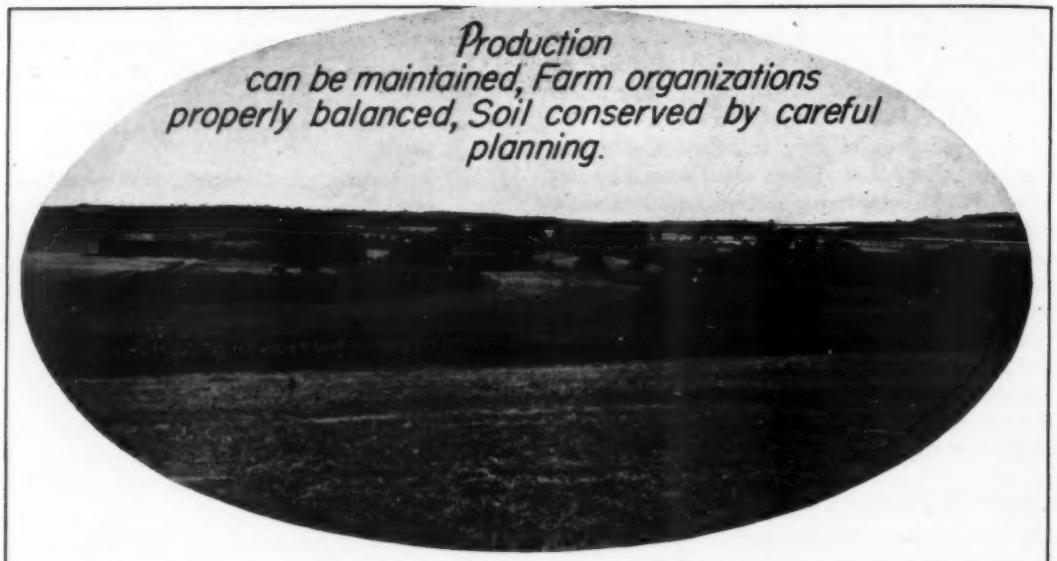
Plan for the Individual Farm

Inasmuch as not all farms in an area are identical, the general plan of work for the area will not fit all farms. It is therefore essential that certain information be obtained on each farm before planning begins. For those farms included in the sample of the area, this information will already have been obtained. On individual farms such data should include the kind and amount of livestock, the feed which has been available for this livestock, the amounts of feed purchased, and the acreage, yield, and sales of principal cash crops. With this reconnaissance data at hand, it is possible to determine those changes which should be made to correspond with the livestock feed needs of the farm. After the tentative plan for the farm is developed, a check should be made to determine to what extent the needs have been met, and if necessary the plan should be revised. A study should also be made of the net income possibilities under the new plan as compared with the old.

Determine Need for Change

Even though all information is available when the farm is planned, it may be impossible to develop a plan which fully meets the needs or to get the farmer to

(Continued on p. 266)



THE APPLICATION of FARM MANAGEMENT DATA in FARM PLANNING

By Melville H. Cohee[1]

FROM the physical point of view alone it is entirely possible that a group of properly selected scientists can draft the ideal soil- and moisture-conservation program for a specific tract of land. Because of the social demands made upon that same tract of land, however, it is mandatory that when designing programs the economic aspects of land-use methods and practices be given parallel attention with the physical facts.

Point of First Consideration

It is recognized that in the past many different types of conservation programs failed to attain success because it was impossible to secure proper consideration or development of the economic phases of either proposed or established plans. For example, history tells us that during the last half of the nineteenth century a definite effort was made to establish a long-time forestry-conservation program in the United States. But despite the fact that the leaders recognized the economic phase of the program, it suffered from a lack of cooperation on the part of land owners who had a vision far shorter than that of the leaders. Consequently, complete adoption of this particular conservation program was delayed.

An appraisal of the type of farming, with adequate attention to the land use and individual farm organization, is definitely necessary in a study to determine a soil- and moisture-conservation control program for any area. Before starting work in an area, an over-all plan should be drafted and all parts properly coordinated so that it will serve as a guide to those who work out the plans for individual farms.

Given such factual information as is available from a physical and economic review of existing conditions in an area, the physical scientists and economists become fortified to draft project working plans which should be lacking in no phase. Neither type of information alone will furnish an adequate basis for recommendation, but both types should be analyzed in the light of their historical background.

From Project Plans to Individual Farms

Each individual farm offers a challenge—this because the complicated problems involved are peculiar to the farm. The conservationist who is planning a program of soil and moisture conservation for the individual farm will be confronted with a task of a twofold nature; first, he must determine the individual problems as they are like and unlike those covered by the project working plans; and secondly, he must

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apply correctly the general plans, as previously decided to be desirable for the area, to the individual farm.

It is only as general recommendations are applied to individual farms, which may be operated according to different organizations, that the project working plans become effective for the area. Consequently, it is essential that any agency offering aid to farmers desirous of reducing soil and moisture losses should have at hand a general plan which is sufficiently flexible to permit application to individual farms. Furthermore, because of this method of approach, it should be expected that farms with almost identical physical conditions might require programs differing in the solution of their individual problems.

Balancing the Farm Organization

Farms operated almost entirely for cash-crop sales do not offer the number of opportunities for combination of enterprises as do live-stock farms. For the cash-crop farms the changes in land use and methods of farming warrant direct consideration of input and output. However, for the livestock farm the possibility of balancing varying amounts of feeds and pasture supplies against different numbers and types of livestock does allow for wider consideration of several possibilities of cropping programs and methods.

For the type of farming where livestock enterprises are a part of the organization, and to which this discussion will be confined, it is very easy to disrupt a farm organization by introduction of practices and methods directed toward soil and moisture conservation. To illustrate use of farm-management information in planning a conservation program, the John Brown farm may be used.

The Individual Farm

This farmer had 6 horses and 1 colt, 8 dairy cows and 4 one-year-old heifers, 6 brood sows and 36 young pigs, a flock of 100 laying hens and 200 pullets and cockerels. To meet the feed demands of this livestock and poultry the farmer had the following crop distribution: Alfalfa, 7 acres; clover and timothy, 20 acres for hay and 10 acres for pasture; timothy and bluegrass hay, 8 acres; oats, 15 acres; barley, 20 acres; corn, 50 acres; open permanent pasture, 25 acres. Using standard feed requirements for the above livestock, the farmer needs approximately 1,192 bushels of corn or its feed equivalent in grain, 36 tons of hay and 41 acres of pasture of good to medium quality. Mr. Brown's crop acreage with average yields for the area will allow production of 3,203 bushels of corn or its grain equivalent, 48 tons of hay, and 35 acres of good to medium pasture.

From a purely farm-management point of view, it would seem that this farmer is understocked in all respects except for pasture, while from a soil-conservation point of view it is known that his crop yields are decreasing and that he is rapidly losing his soil because of erosion. The farmer realizes that despite the fact that he does well with his livestock, his entire farm organization is not bringing such returns as he realized a few years ago.

Changes

The soil- and moisture-conservation project working plans, for the area in which Mr. Brown's farm is located, call for reduction in clean-tilled crops and retirement of the badly eroded and steeper areas to permanent pasture. The first application of the plans to this particular farm resulted in plans for retirement of 10 acres of cropland to permanent pasture. To improve the farm organization, the 8 acres of old hay land which are unsuitable for clean-tilled crops will be retired to pasture. This will increase the permanent pasture area to 43 acres. The remaining cropland area will be devoted to the following crops with a 3-year and 4-year rotation, except for the alfalfa area which will be a 6-year rotation: Alfalfa, 15 acres; clover and timothy, 30 acres; oats, 20 acres; barley, 20 acres; corn, 35 acres. The clover and timothy hay land will be used approximately half for hay and half for pasture. The operations to be carried out on the cropland are planned in accordance with good conservation practices such as contour tillage, strip cropping, buffer strips, sodded draws, etc.

The farmer desires to increase his numbers of livestock and will have 6 horses and 2 colts, 10 dairy cows and 6 heifers, 7 sows with 2 litters annually rather than 1, and 100 laying hens and 200 young chickens. With these numbers in the different livestock enterprises, the annual feed requirements will call for approximately 2,000 bushels of corn or its grain equivalent, 44 tons of hay, and 56 acres of good to medium pasture. To meet these requirements and assuming no increase of yields per acre with the planned cropping program, the farmer should produce 2,545 bushels of corn or its grain equivalent, 53 tons of hay, and 58 acres of good to medium pasture.

From a consideration of land use, crop-production data, and the livestock feed requirement data, it is evident that the farmer has made plans to meet the

two most important needs. First, he has made shifts in his land-use program to meet soil-conservation requirements for his farm. Second, he has planned his farm-management program to meet those changes. He will have a better balanced organization than he had before, with possibilities of making the best use of his own time and that of hired labor throughout the entire year.

It is true that from consideration of only the physical factors of the farm such as degree of erosion, slope, and soil type, recommendations could justifiably be made whereby the farmer would retire 25 acres of cropland to permanent pasture and reduce his corn and grain acerage to 60 acres. On the other hand, it is inadvisable from a farm-organization standpoint to reduce his grain acreage further, as this would demand a compensating increase in his hay acreage. With the planned program he will have a small surplus of hay and likewise he will have extra grain. These surpluses will allow expansion of his livestock program, preferably to either more hogs or a few feeder cattle, since his pasture supply is not adequate to care for added numbers of livestock which ordinarily use an appreciable acreage of pasture during the summer months.

Plans Should be Justifiable

Summary and analysis of farm-management data for two farms is presented in the table. Insofar as present information regarding erosion control is available the land-use and cropping rotation programs planned for these farms are suitable for reducing the soil and moisture losses to a minimum. If the proposed plans were slightly different, however, an equal amount of control could be rendered from a physical standpoint, and at the same time permit better organizations.

Feed	Farm 1			Farm 2		
	Hay (tons)	Grain (bushels)	Pasture (animal units)	Hay (tons)	Grain (bushels)	Pasture (animal units)
Available, 1934	33	988	130	26	563	65
Required, average 1935–39	51	1,030	125	23	353	55
Estimated production,						
1935	50	1,199	113	34	554	43
1936	85	808	104	30	784	43
1937	111	441	104	30	711	43
1938	129	588	89	41	396	43
1939	122	665	89	41	631	43

NOTE.—Farm 1: $90 worth of grain was purchased in 1934. The plans call for too much hay and inconsistent amounts of grain and pasture, mostly inadequate to meet requirements. Farm 2: The plans call for more grain than needed and the amounts produced in different years are too variable for best farm-management planning. Too much hay will be produced but the pasture supply will be inadequate.

Supplemental information available to the conservationist shows that farm 1, as indicated in the table, has hay growing on A- and B-slope fields for a period of 4 or 5 years, and then it is broken for corn and grain followed by a seeding to hay. It is also known that these areas are well drained and suitable for shorter rotations. Plans could have been made to include part of this hay land in shorter rotations, which would have balanced the grain production against feed requirements and permitted rotation plans of such a nature that the irregularity of total grain production could be eliminated. Also the farm-management data indicates that there will be a shortage on pasture and an oversupply of hay. Therefore, by cropping some of the meadow and pasturing some other parts of it, the total hay production for the farm could be reduced and the grain and pasture supplies could be balanced with livestock requirements.

As planned by the conservationist, farm 2 will have irregular grain production over the period 1935 to 1939. It is likewise evident that the hay production will be too great and the pasture supply too low for the livestock needs. The conservationist overlooked also the possibility of removing a fence on some B-slope land. This would have allowed redistribution of field acreages and in turn a more balanced acreage resulting in consistent production of different feeds. No plans were made for pasture improvement, but fortunately it is possible to add considerable production by proper treatment of the area. If these changes were made on the farm, the farmer undoubtedly would experience appreciably increased returns in addition to those possible from the present plans. The increased returns would in all probability more than compensate for the necessary costs of the added treatments.

It is recognized that a soil-conservation program must be justified on a long-time basis, and from either the private or public standpoint. The farmer probably will not go through with the academic process involving careful calculation of feed requirements over a period of years and balancing of this process against crop, range or pasture acreage and anticipated yields and carrying capacities. On the other hand, if the planned land-use program fails to fit one of the various profitable organizations which are possible for his farm the farmer will discover this fact as a result of trial and error procedure. One task ascribed to the conservationist is to see that the soil- and moisture-conservation plans are sound from a farm-management and organization standpoint.

WATERSHED CONTROL IN ITALY

(*Continued from p. 251*)

2. *Reclamation works* on the plains and in the foothills—flood control, water storage, drainage, and irrigation.

3. *Improvement works* for the intensive development of agriculture—provision of roads, water supply, electric power plants and transmission lines, erection or reconstruction of rural villages and farm buildings, improvement of agricultural methods through education demonstration, the promotion or rehabilitation of land settlement.

4. *Sanitation works*, principally for the suppression of malaria.

Collectively, these measures are designed to increase employment, expand purchasing power, and add to the national income; settle on the land surplus industrial labor and migratory agricultural labor; intensify and stabilize the production of agricultural, forage, and forestry crops on appropriate soils; withdraw from cultivation or pasturage inappropriate soils; utilize water resources for electric power, irrigation and navigation; prevent soil erosion and floods; rehabilitate and modernize rural centers; promote health; and through example provide education in improved methods of farming.

"Bonifica Integrale" embraces several cardinal principles:

1. The integration of the services which contribute to the organization and execution of the work.

All services in the Government departments which were connected with land development in one way or another have now been coordinated or transferred to the Ministry of Agriculture and Forests and placed under a special Under Secretary of State for Land Reclamation. This was done to secure the most effective collaboration and coordination between engineering, agriculture, and forestry—to secure unity of conception as well as unity of execution.

These specialized branches are supported by cooperative agencies such as the Department of Public Health and the Commission for Internal Migration and Colonization—the first for the work of malaria control and the second for the adjustment and settlement on the land of surplus and migratory labor.

2. The integral character of the execution of the work in the field.

Past work was largely directed to flood control in the lower courses of rivers or simply to the drainage of marsh areas. This work was unproductive and did not fulfill the ultimate purpose of the settlement and cultivation of the land. The direct relation between the devasting effects of mountain waters and the consequent disturbance of the water regime on the plain was ignored. In Italy at present improvement work in the mountain area is considered to be a necessary preliminary condition for improvement work on the lowlands. In any case it is now an accepted principle that these two classes of work must be carried out in close relation with one another.

All work of whatever character is undertaken as a unit operation within a definite area—the conservation works in the mountain watersheds (reforestation and soil erosion control), the reclamation and flood control of the plains, the improvement works for intensive cultivation and settlement and finally the work of malaria control, proceed concurrently. No project is independent or localized.

Under present policies areas are classified by the Minister of Agriculture and Forests, in agreement with the Ministers of Finance and Public Works after a special technical committee of agronomists, foresters and engineers, acting through the Under Secretary of State for Land Reclamation, has expressed an opinion.

The selected areas are those where in the public interest it is desirable to undertake integral measures of conservation, reclamation, improvement, and rehabilitation. The character of the work to be done and its degree of importance as a public utility determines its classification and category (priority), and hence the measures and extent of State cooperation and aid and the type of organization necessary to accomplish the objectives of the plan.

Projects of the first category (priority) are those which have an exceptional importance in the public interest, and which require expenditures too great to be undertaken by private enterprise alone. They are generally taken in regions where for serious physical or social causes the national resources of the soils and waters are wasting or are unproductive, or where life and property are endangered by recurrent floods and landslides or by the presence of malaria breeding conditions.

For each classified area a general plan must be drawn up and approved by the Under Secretary if the project is to be executed with the assistance of the State. This plan will include the fundamental principles requisite to carry out the purpose of reclamation and to assure the utilization of the potential resources of the area.

(*Continued on p. 266*)

ATMOSPHERIC CIRCULATION

(Continued from p. 255)

hazard is, of course, increased many fold if this sporadic rainfall pattern is superimposed upon a soil well saturated from existing warm-front precipitation. Not only is there greater run-off but mass movements of the soil by downhill creep and by slumps and other forms of slippage is promoted.

The previous maximum flood stage of the Ohio at Cincinnati in February 1884 and the Dayton flood of March 1913 occurred as shown by Humphreys' charts [4] when there was a westward displacement of the Azores anticyclone and abnormally high temperatures in the eastern United States.

It is of interest to note that the westward shift in the Azores anticyclone was accompanied by a displacement to the north and west of the Pacific anticyclone. This is shown on figure 1. This shift was correlated with a weakened pressure field over the southwestern United States which permitted frequent invasions of Polar Continental air masses into the Rocky Mountain and Pacific coast regions, accounting for the abnormally low January temperatures.

[4] Humphreys, W. J.: local citation.

The episodic fluctuations in climate are those which most concern us, for it is the extreme variations which bring about the unanticipated flood and drought hazards. An excess or deficiency in precipitation for any one area must necessarily bear a direct relationship to the change in the meteorological conditions usually prevailing in the region, and it is obviously futile to attempt to determine the critical limits of drought or flood conditions for an area without regard to the genesis of complete storms. A study of 50 or even 100 years of climatological data from various stations sparsely scattered about various watersheds may yield no indication whatsoever as to the climatic extremes that may develop from the active meteorological forces if all were simultaneously called into play.

The province of climatology in soil conservation is necessarily one of enlightenment. The climatologist must recognize and inform others of the climatic risks and hazards. Human endeavor can anticipate and prepare for the extreme conditions which produce floods and thereby lessen their ravages, but we do not expect to prevent their occurrence.

FARM MANAGEMENT INFORMATION NEEDED

(Continued from p. 261)

adopt it in its entirety. Additional studies should be carried through from time to time to see how the plan is fitting in with the needs and what additional changes should be made. This information could be obtained either by repeat surveys, or by farm-account records. Since the farmer is more willing to make changes based upon data which he himself helped to compile, it seems advisable that as many cooperators as possible be encouraged and assisted in keeping farm-account records. It is advantageous, wherever possible, that this farm-account work be carried on in cooperation with the college of agriculture, since in most States the colleges already have well-developed programs in farm-account work. These additional records will add to their program, and the extension specialists can be of considerable assistance to the Soil Conservation Service in helping to summarize and analyze these data, and in planning an economically sound program.

AGRICULTURE'S NEW APPROACH

(Continued from p. 246)

The bureaus will carry the technical load and, as explained, the preliminary examinations, at least, will be carried on in the field by their representatives working as committees. This type of cooperation is new to the Department and is being watched with a great deal of interest. To date there is every evidence that it will succeed and that it will open the door to a broader, more comprehensive method of departmental approach in many fields.

WATERSHED CONTROL IN ITALY

(Continued from p. 265)

3. Encouragement of private enterprise in cooperation with the State.

The Government's services are supported by auxiliary reclamation, veteran, and farmer agencies.

Landowners are organized into more than 1,000 associations ("consortia") for the development, execution, management, and upkeep of projects. These associations have the legal character and function of public utility corporations.

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the maps. From time to time the surveyors checked their observations with the impressions of the residents. Sometimes the farmers had observed accurately and thoroughly, and sometimes their ideas were completely erroneous as far as this disaster was concerned. It would have been interesting to know how this flood compared with others which they have experienced.

Analyses To Follow

As previously intimated, all effort thus far expended has been concerned with the securing of survey data before the farmers disturbed the soil. No time has been available to study the 200 (approximately) cross-section surveys which have been made; and in order to prepare a reliable summary of the work it will be necessary to measure the maps, make moisture determinations on the samples, calculate the probable total deposits and removals for the unmapped areas, and to summarize these data for the various sections of the valley. While no definite statements can be made at present about the findings of this survey, a few general comments based on field observations can be offered.

The Flooded Zone

As a basis for understanding the following comments, a few facts about the flooded zone in the valley itself are necessary. Above Point Pleasant, W. Va., the flooded zone was less than that of the 1913 flood, and beyond this point it was greater than that of all known floods. In general, the flooded zone increased gradually in width from Pittsburgh to Cairo. In the upper part of the valley the distance from the river bank to the edge of the flooded area rarely exceeded one-fourth mile in width, while below Owensboro, Ky., this zone at times exceeded 5 miles in width. Three important exceptions occur—one between Cincinnati and Louisville and two between the latter city and Owensboro. In these locations the Valley of the Ohio narrows until it assumes almost a gorgelike aspect, and the conditions encountered in the flooded area here differ materially from those just above and below. Another fact of interest is that practically all the farms in the valley were affected in some way. As the river was the important highway at the time the area was settled, practically all property lines run at right angles to the river bank. Consequently, each farm has a "river front" and extends back to the base of the hills.

The flood plain along the 983 miles of river may be divided roughly into three parts. The valley from Pittsburgh to Cincinnati constitutes one division and is characterized chiefly by moderate deposits and removals, with the area affected rarely extending over one-fourth mile from the river bank. While many of these removals and deposits were often probably only ½ to 1 inch in depth, their effect, combined with that of the water coverage, usually resulted in ruin for winter wheat and alfalfa seedings. No appreciable deposits were found near the upland unless there was a swale or depression leading down from the main channel. This condition was general throughout the valley, and in no instance did the writer observe more than a trace of deposit in an area filled by backwater from the river. In fact, were it not for the telltale line of trash left at the high-water mark, it would be impossible to tell that most of these areas had been flooded. This and other supporting observations lead to the conclusion that the main silt load was carried in the zone of strongest current, and that this zone followed the regular channel.

Deposits on Wide Flood Plains

Another part of the flood zone having distinct characteristics is the area of wide flood plains which occurs below Cincinnati. In this part, with the exception of a zone on either bank of the river about one-fourth mile wide and parallel to the channel, deposits were usually found only where trees and brush checked the rate of flow. As these occurred chiefly in swampy areas, little deposit was left on the cultivated land. These deposits rarely exceeded ⅜ to ½ inch in depth (dry basis). Different conditions were found in the vicinity of the two large bends near Evansville, Ind. These bends lay in a location apparently subject to unusual current conditions, and uniform deposits of ½ to 2½ inches of silt and silty clay were found over appreciable areas in this part of the valley.

Bottom Land Soils

Soil survey maps of scattered areas along the Ohio River show that in general the bottom land soils are silty in nature, with silt loams predominating. Relatively small areas confined to back bottoms are silty clay, and narrow strips along stream edge are in places sandy. Many of the deposits of sand in the recent flood were laid down upon silty soils, and where de-

(*Continued on following page.*)

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

THE FUTURE OF THE GREAT PLAINS, a publication of the Great Plains Committee, will be reviewed in this department in June. Curtailed space requires its omission from this issue.

(*Continued from preceding page.*)

posits of sand are deep, some of the best soils of the valley have been ruined for agricultural purposes. Silt deposits may be considered an advantage rather than a detriment, as deposition is the natural process by which such bottom land soils are formed.

The deposition of silty material was greatest in pockets of the bottoms where eddies formed, and in estuaries of the lateral tributary streams in the regions where the streams carried a heavy load of sediments.

Gouging

As would be expected, the gorgelike areas of valley—the third division—showed evidences of bank cutting and hole "gouging", usually associated with sand coverage. Drifts of medium sand 6 to 7 feet in depth have been observed in some localities, and areas as much as 250 yards wide were sometimes covered to an average depth of 6 to 10 inches. Such areas are hopelessly ruined unless a future flood removes the sand. In general it might be said that the entire area from Cincinnati to Cairo has an appreciable amount of sand coverage. The sandy deposits occur along the stream edge of the bottoms. In most cases this presents a serious problem, as a sand drift has no greater agricultural possibilities in the Ohio Valley than on the Great Plains.

Removal of soil from fields by cutting action of flood waters has occurred in numerous places throughout the entire flooded area of the Ohio River, but is more pronounced between Cincinnati and Cairo. There has been little gouging except where flood waters made short cuts across bends. These areas, although spectacular in appearance and devastating to the land where they occur, are confined to comparatively small areas. Sheet cutting in general is widespread, consisting of the removal of ½ to 6 inches of the surface soil from entire fields, while in places near the streams cutting has sometimes been as much as 1 to 2 feet deep. These areas are usually found where the flood waters were constricted in rather narrow bottoms and reached a depth of 30 to 50 feet or more.

The most severe and widespread damage of this kind occurred upon plowed fields, corn stubble, and soybean stubble, whereas alfalfa, grasses, or even a cover of weeds furnished remarkably good protection. On some of the more exposed positions close to the main channel where the river was straight, or where the water had a tendency to cut across bends, even the best cover was not sufficient to prevent cutting. As corn is the leading crop of the valley, it may be readily seen that much of the land was in prime condition for cutting, and to this fact alone is due much of the loss sustained upon farm lands.

In addition to the silt, clay, and sand deposits, the entire valley, particularly from Portsmouth to Cairo, is littered with drifts of trash. These vary in composition from cornstalks and whisky barrels in one area to brush, logs, and wrecked buildings in others. They occur in fence corners, groves, drainageways, and even in open fields, and cover areas from 1 or 2 rods square to 2 or 3 acres. At present they constitute a very noticeable feature of the area, and one of considerable annoyance to the farmer. However, given some dry weather, a match and some kerosene will eliminate this problem.

Tributary Valleys

Uniform deposits of silt, rarely exceeding 2 to 3 inches in depth, were noted in the valleys of some of the tributaries. However, these deposits did not extend more than a few miles above the mouth, and no important deposits were noted on the south or east sides of the Ohio River. The valley of the Kanawha River, for example, had no trace of deposit above its mouth, whereas the Miami, Scioto, and other rivers in Ohio contained silt deposits at their mouths. To date, no survey has been made on the mouth of the Wabash River.

The above observations relate only to the outstanding, easily noted effects of the flood. What it actually meant in tons of soil deposited or removed from alluvial lands, acres of land altered or destroyed, and a number of other things can be estimated only after the field data have been analyzed. Unfortunately the preflood conditions can only be estimated by approximation. It is hoped, however, that the final analysis will bring to light a number of interesting facts as yet unsuspected.

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